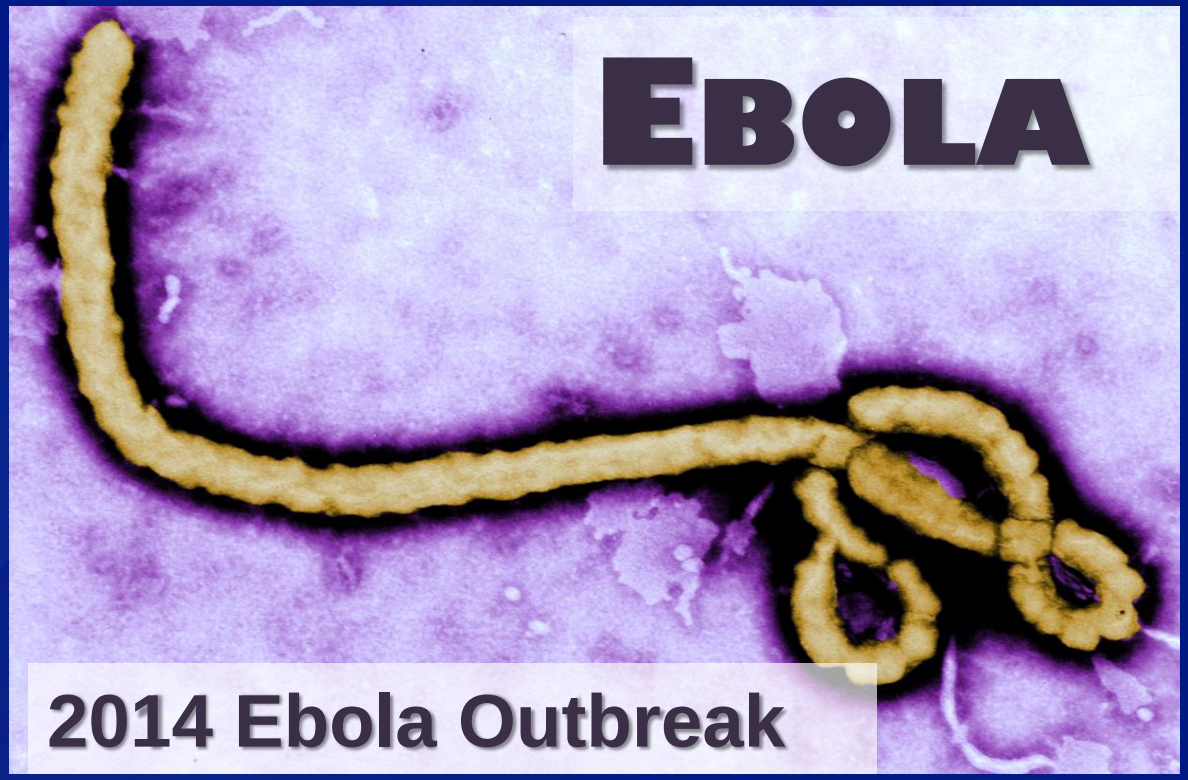
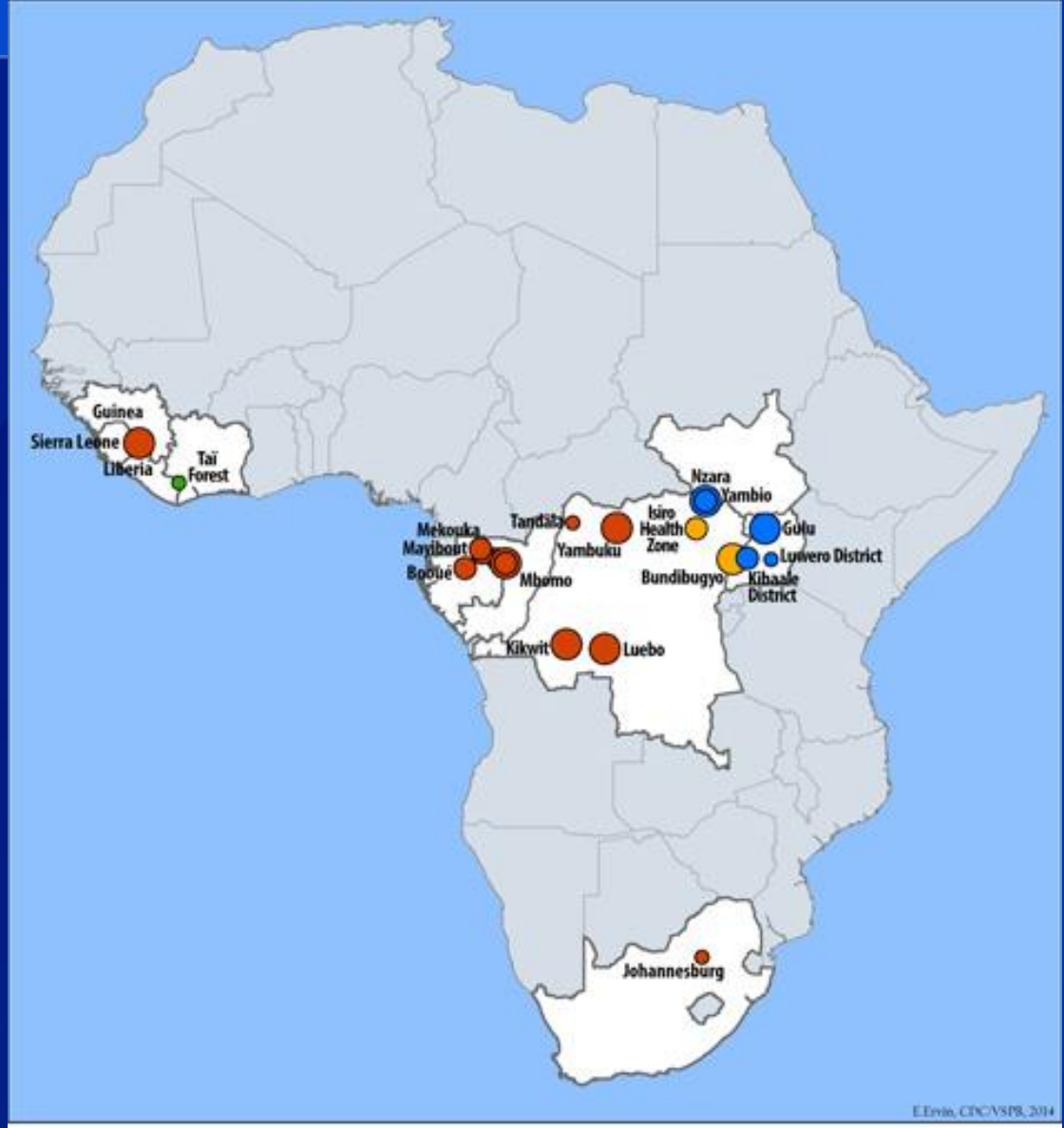
# 2014: The Year of Ebola



# Ebola Virus Disease

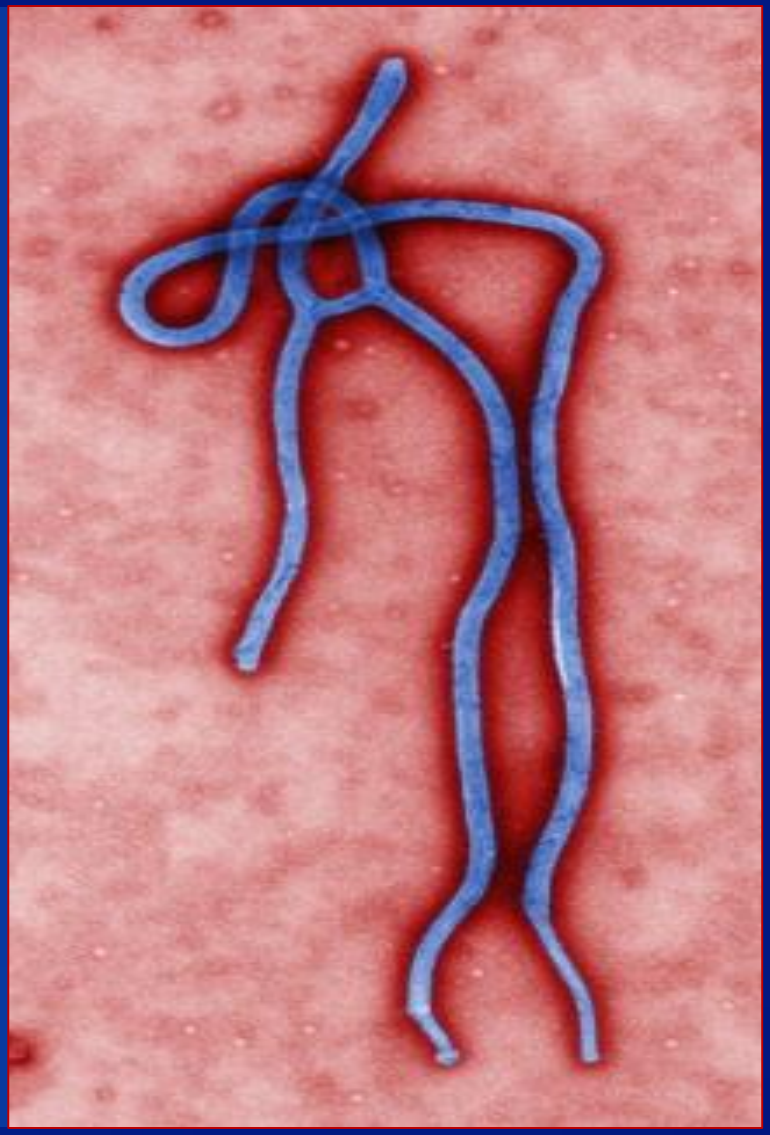
- First discovered in 1976 near Ebola River in Democratic Republic of the Congo
- Outbreaks occur sporadically in Africa
- Family of zoonotic RNA viruses
  - Filoviridae
  - Enveloped



# Ebola Virus Disease

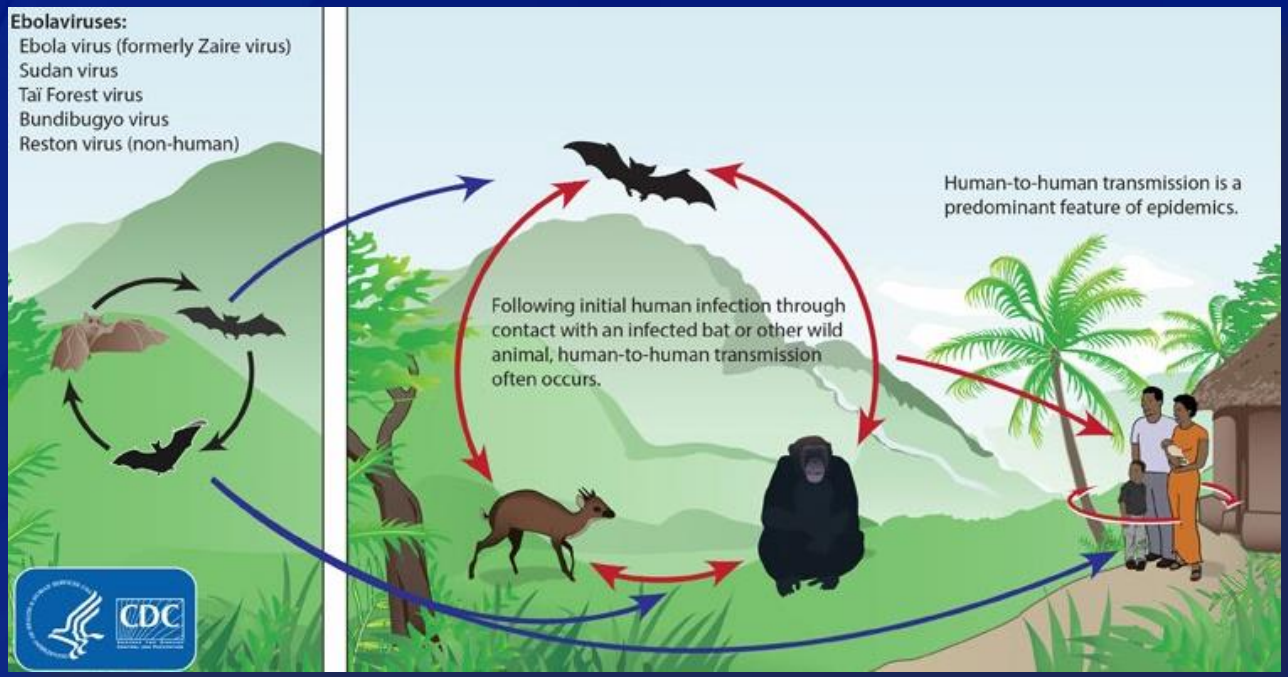
- Previously called Ebola hemorrhagic fever

- 5 species of *Ebolavirus*
  - *Zaire ebolavirus*
  - *Bundibugyo ebolavirus*
  - *Reston ebolavirus*
  - *Sudan ebolavirus*
  - *Tai Forest ebolavirus*
  - *Reston ebolavirus*



# Ebola Virus

- Bats most likely reservoir, although species unknown
- Spillover event from infected wild animals (e.g., fruit bats, monkey, duiker) to humans, followed by human-human transmission



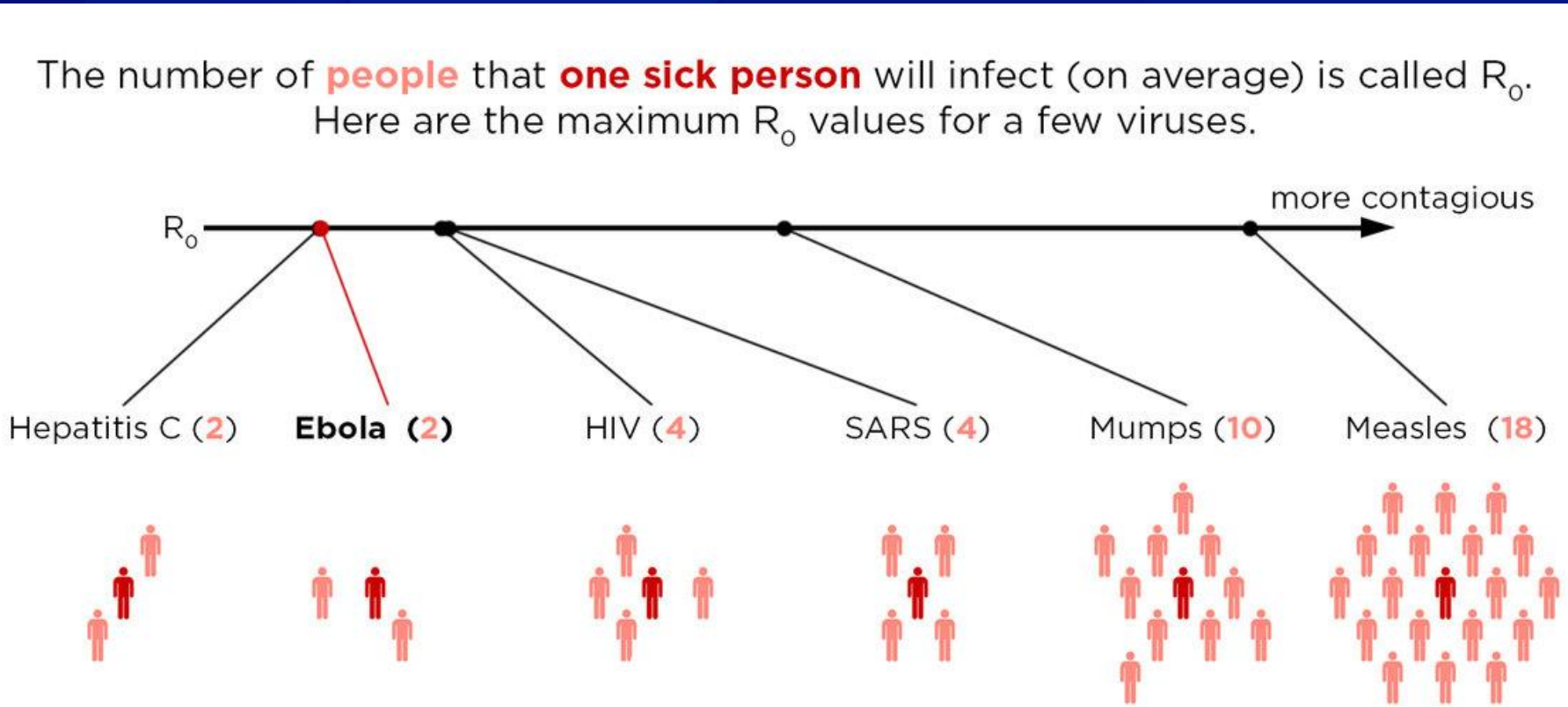
# Epidemiology

- **Not infectious before illness onset**
- **Incubation period 2–21 days**
  - Usually 8–10

# EVD Transmission

- **Routes of human-to-human transmission**
  - Direct contact with blood or body fluids
  - Contact with contaminated objects (such as needles)
  - Direct contact with corpse of person who died of EVD
- **Transmission via inhalation (aerosols) has not been demonstrated**
- **Can be transmitted via contact with blood, fluids, or meat of an infected animal**
  - Limited evidence that dogs become infected with Ebola virus
  - No reports of dogs or cats becoming sick with or transmitting Ebola

# How Contagious is Ebola?

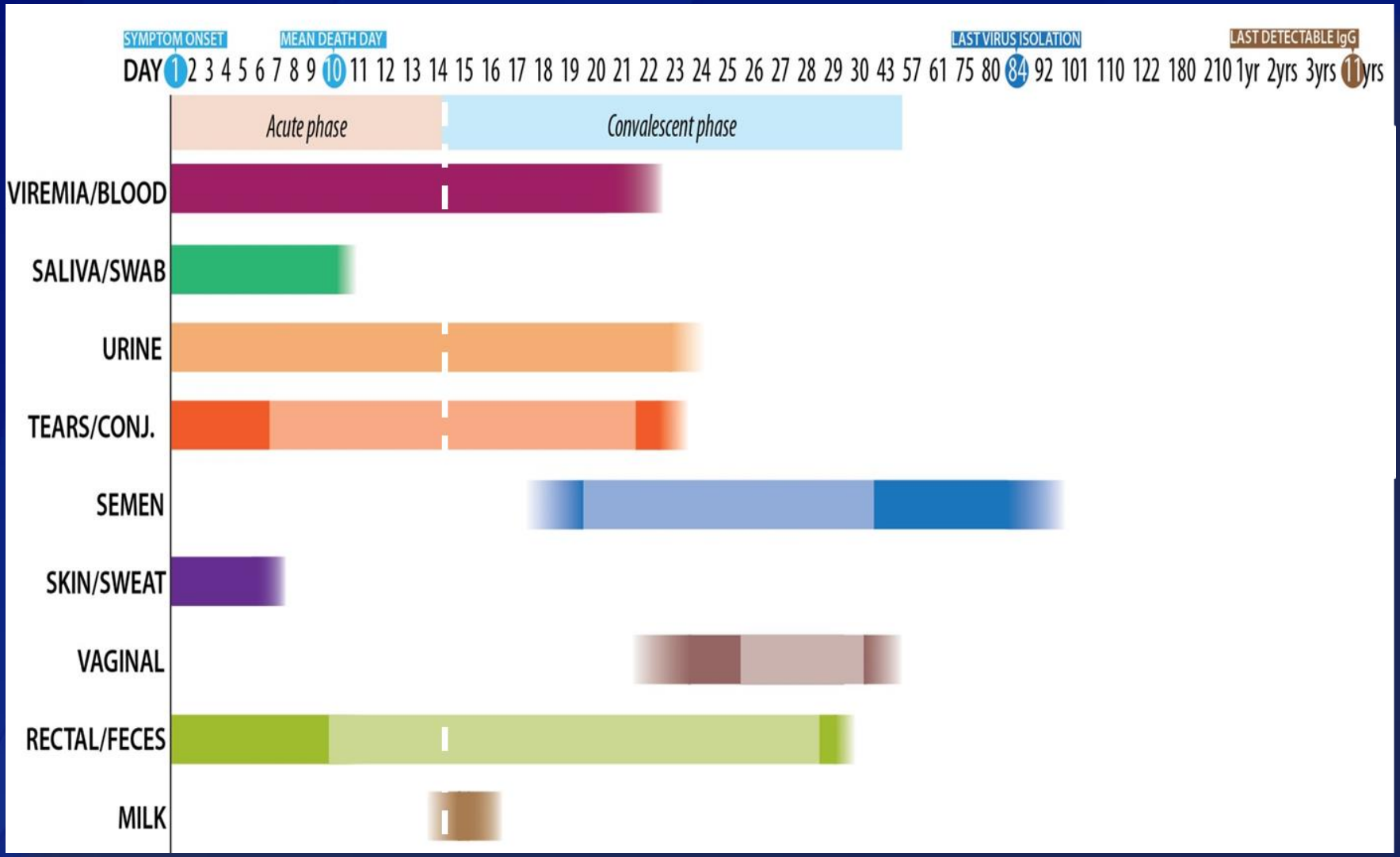



http://www.npr.org/blogs/health/2014/10/02/352983774/no-seriously-how-contagious-is-ebola

# How Contagious is Ebola?

- **Infectiousness of body fluids (e.g., viral load) increases as patient becomes more ill**
  - Remains from deceased infected persons are highly infectious
  - Viral loads 5–10 billion copies/mL of blood
- **<20% of household contacts infected**
  - Only those with direct contact
- **Limited evidence for environmental persistence/spread**
  - Enveloped virus; not stable outside body
  - RNA detectable only on visibly contaminated surfaces

# Detection of Ebola Virus in Different Human Body Fluids over Time



# Clinical Manifestations

- **Nonspecific early symptoms progress to:**
  - Hypovolemic shock and multi-organ failure
  - Hemorrhagic disease
  - Death

# Clinical Manifestations by Organ System in West African Ebola Outbreak

| Organ System | Clinical Manifestation |
|---|---|
| General | Fever (87%), fatigue (76%), arthralgia (39%), myalgia (39%) |
| Neurological | Headache (53%), confusion (13%), eye pain (8%), coma (6%) |
| Cardiovascular | Chest pain (37%), |
| Pulmonary | Cough (30%), dyspnea (23%), sore throat (22%), hiccups (11%) |
| Gastrointestinal | Vomiting (68%), diarrhea (66%), anorexia (65%), abdominal pain (44%), dysphagia (33%), jaundice (10%) |
| Hematological | Any unexplained bleeding (18%), melena/hematochezia (6%), hematemesis (4%), vaginal bleeding (3%), gingival bleeding (2%), hemoptysis (2%), epistaxis (2%), bleeding at injection site (2%), hematuria (1%), petechiae/ecchymoses (1%) |
| Integumentary | Conjunctivitis (21%), rash (6%) |

WHO Ebola Response team. *NEJM*. 2014

# Examples of Hemorrhagic Signs

**Hematemesis**

**Gingival bleeding**

**Bleeding at IV Site**

# Clinical Management of EVD: Supportive, but Aggressive

- **Symptomatic management of fever and gastrointestinal symptoms**
- **Intravenous fluid resuscitation**
- **Electrolyte repletion**
- **Multisystem organ failure can develop**
  - Oxygenation, mechanical ventilation
  - Dialysis

Reference: Fowler RA et al. *Am J Respir Crit Care Med*. 2014

# Investigational Therapies for EVD Patients

- **No approved Ebola-specific prophylaxis or treatment**
  - Therapeutics in development
    - Convalescent serum
    - Therapeutic medications
      - Zmapp – three chimeric human-mouse monoclonal antibodies
      - Tekmira – lipid nanoparticle small interfering RNA
      - Brincidofovir – oral nucleotide analogue with antiviral activity
      - Favipiravir – oral RNA-dependent RNA polymerase inhibitor
  - Vaccines – in clinical trials

**References**: [1]Huggins, JW et al. *Rev Infect Dis* 1989; [2]Ignatyev, G et al. *J Biotechnol* 2000; [3]Jarhling, P et al. *JI*D 2007 S400; [4]Mupapa, K et al. *JID* 1999 S18; [5]Olinger, GG et al. *PNAS* 2012; [6]Dye, JM et al. *PNAS* 2012; [7]Qiu, X et al. *Sci Transl Med* 2013; [8]Qiu, X et al. *Nature* 2014; [9]Geisbert, TW et al. *JID* 2007; [10]Geisbert, TW et al. *Lancet* 2010; [11]Kobinger, GP et al. *Virology* 2006; [12]Wang, D *JV* 2006; [13]Geisbert, TW et al. *JID* 2011; and [14]Gunther et al. *JID* 2011; Oestereich, L et al. Antiviral Res. 2014.

# Patient Recovery

- **Case-fatality rate ~70% in 2014 Ebola outbreak**
  - Lower with access to intensive care (~50%)
- **Patients who survive often have signs of clinical improvement by ~ day 13**
- **Prolonged convalescence**
  - Includes arthralgia, myalgia, abdominal pain, extreme fatigue, and anorexia; many symptoms resolve by 21 months
  - Significant arthralgia and myalgia may persist for >21 months

**References**: [1]WHO Ebola Response Team. *NEJM* 2014; [2]Feldman H & Geisbert TW. *Lancet* 2011; [3]Ksiazek TG et al. *JID* 1999; [4]Sanchez A et al. *J Virol* 2004; [5]Sobarzo A et al. *NEJM* 2013; and [6]Rowe AK et al. *JID* 1999.

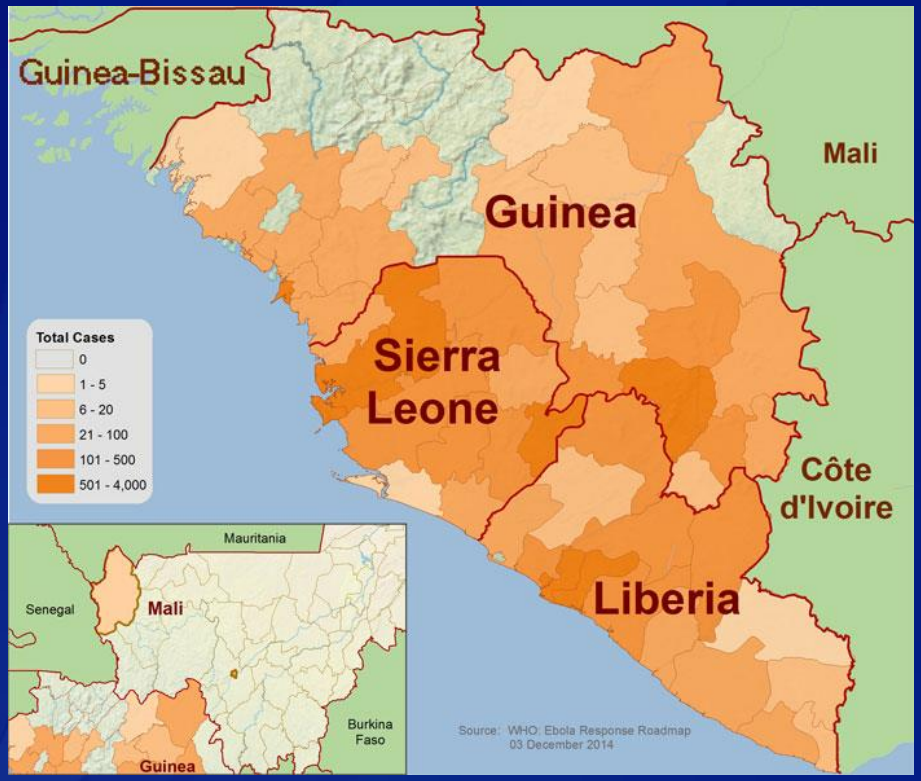
# OUTBREAKS

# Outbreak in Historical Perspective

| Year began | Country | Ebola virus subtype | Duration (mos) | Rep. No. cases | Rep. No. deaths | Case Fatality Ratio |
|---|---|---|---|---|---|---|
| 1976 | Zaire (Democratic Republic of Congo) | Ebola | 3.5 | 318 | 280 | 0.88 |
| 1976 | Sudan | Sudan | 6.3 | 284 | 151 | 0.53 |
| 1979 | Sudan | Sudan | 3.7 | 34 | 22 | 0.65 |
| 1994 | Gabon | Ebola | 2.6 | 52 | 31 | 0.60 |
| 1995 | Democratic Republic of Congo | Ebola | 7.8 | 315 | 250 | 0.79 |
| 1996 | Gabon | Ebola | 5.0 | 60 | 45 | 0.75 |
| 1996 | Gabon | Ebola | 8.1 | 37 | 21 | 0.57 |
| 2000 | Uganda | Sudan | 4.7 | 425 | 224 | 0.53 |
| 2001 | Gabon & Republic of Congo | Ebola | 6.6 | 65 | 53 | 0.82 |
| 2001 | Republic of Congo | Ebola | 6.3 | 57 | 43 | 0.75 |
| 2002 | Republic of Congo | Ebola | 4.4 | 143 | 128 | 0.90 |
| 2003 | Republic of Congo | Ebola | 2.3 | 35 | 29 | 0.83 |
| 2004 | Sudan | Sudan | 3.8 | 17 | 7 | 0.41 |
| 2007 | Democratic Republic of Congo | Ebola | 7.8 | 264 | 187 | 0.71 |
| 2007 | Uganda | Bundibugyo | 5.6 | 149 | 37 | 0.25 |
| 2008 | Democratic Republic of Congo | Ebola | 1.8 | 32 | 15 | 0.47 |
| 2012 | Democratic Republic of Congo | Bundibugyo | 5.9 | 36 | 13 | 0.36 |
| 2012 | Uganda | Sudan | 4.2 | 11 | 4 | 0.36 |
| 2014 | Guinea, Liberia, Sierra Leone, Nigeria | Ebola | 7.4 | 1603 | 887 | 0.55 |

# 2014 Ebola Outbreak

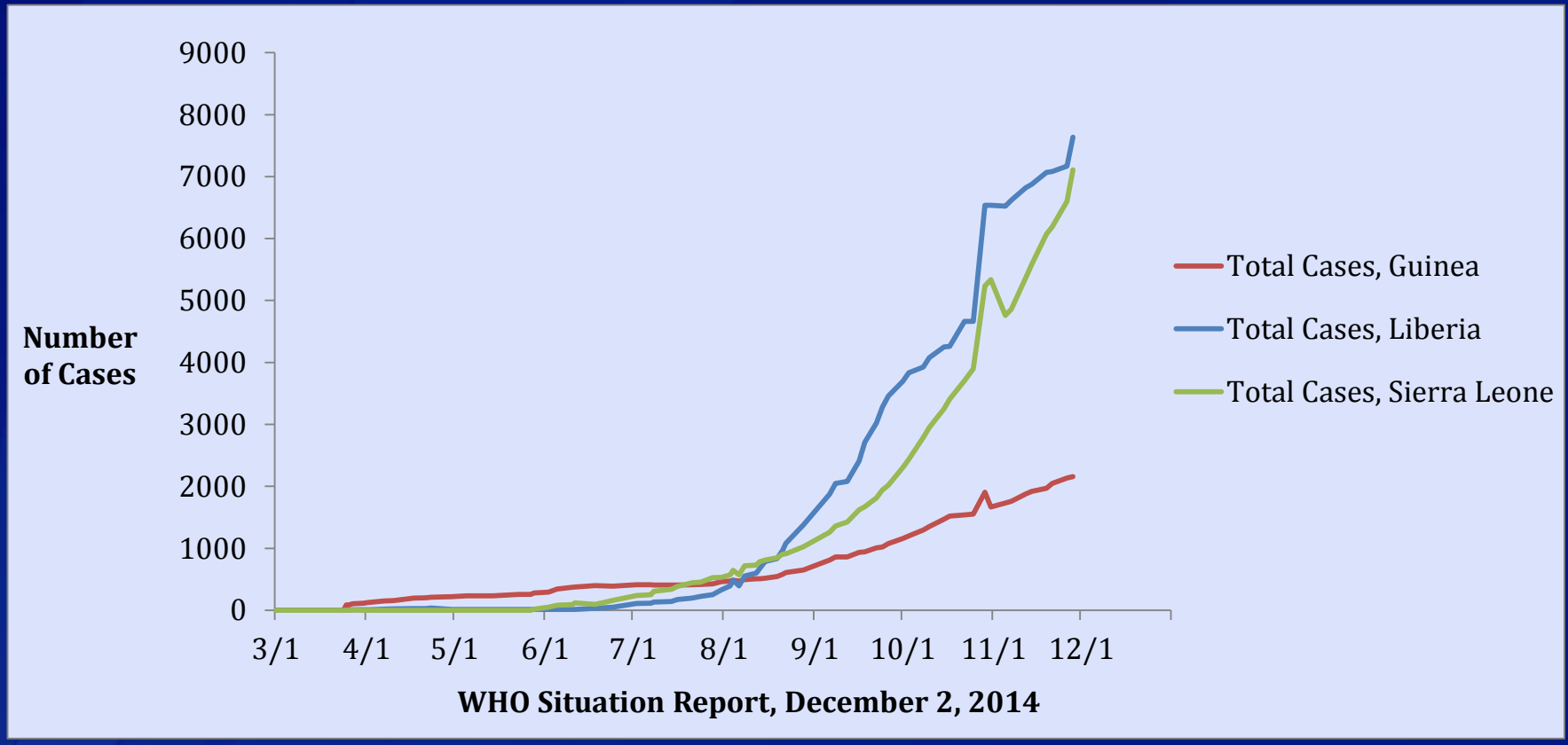
Figure. Ebola virus disease (EVD) cumulative incidence* — West Africa, December 3, 2014




http://www.cdc.gov/vhf/ebola/outbreaks/2014-west-africa/distribution-map.html

- **Largest Ebola epidemic in history**
- **CDC's response is largest international outbreak response in CDC's history**

# 2014 Ebola Outbreak
# Reported Cases in Guinea, Liberia, and Sierra Leone




This graph shows the cumulative reported cases in Guinea, Liberia, and Sierra Leone provided in WHO situation reports beginning on March 25, 2014 through December 2, 2014.

# Ebola Cases and Deaths

*As of December 6, 2014

| | Reporting Date | Total Cases | Confirmed Cases | Total Deaths |
|---|---|---|---|---|
| Guinea | 6 Dec 14 | 2,283 | 2,035 | 1,412 |
| Liberia | 6 Dec 14 | 7,719 | 2,830 | 3,177 |
| Sierra Leone | 6 Dec 14 | 7, 798 | 6,317 | 1,742 |
| Nigeria** | 15 Oct 14 | 20 | 19 | 8 |
| Spain** | 27 Oct 14 | 1 | 1 | 0 |
| Senegal** | 15 Oct 14 | 1 | 1 | 0 |
| United States | 24 Oct 14 | 4 | 4 | 1 |
| Mali | 23 Nov 14 | 8 | 7 | 6 |
| TOTAL | | 17,834 | 11,214 | 6,346 |

- **Updated case counts available at http://www.cdc.gov/vhf/ebola/outbreaks/2014-west-africa/case-counts.html.**
- *Reported by WHO using data from Ministries of Health
- **The outbreaks of EVD in Senegal and Nigeria were declared over on October 17 and 19, respectively; December 2 for Spain

# EVD Cases Diagnosed in United States

- **EVD diagnosed in four people in US**
  - **Index patient** – Traveled to Dallas, TX from Liberia; Ill September 24, Died October 8
  - **TX Healthcare Worker, Case 2** – Ill October 10, recovered October 24
  - **TX Healthcare Worker, Case 3** – Ill October 15, recovered October 28
  - **NY Medical Aid Worker, Case 4** – Medical aid worker in Guinea; Ill October 24, recovered November 11

Information on U.S. EVD cases available at http://www.cdc.gov/vhf/ebola/outbreaks/2014-west-africa/united-states-imported-case.html.

# EVD Cases Transported to United States

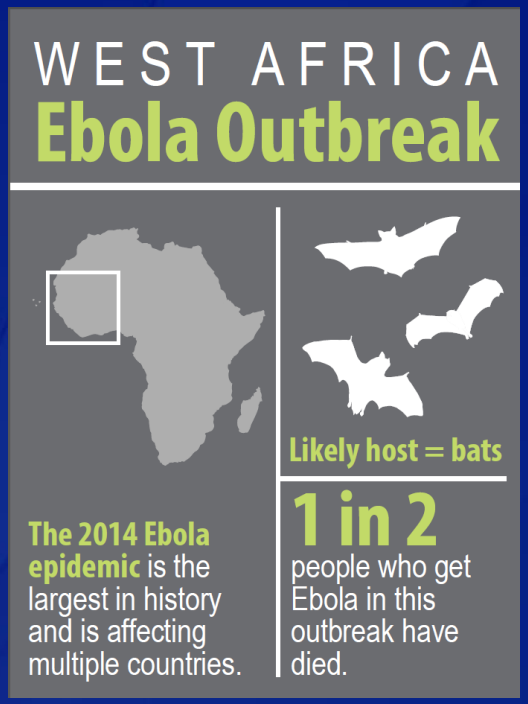
- **Five health workers, one journalist infected in West Africa, transported to US hospitals**

- **Five patients recovered**
  - One health worker died on November 17 after being transported from Sierra Leone to Nebraska Medical Center

Information on U.S. EVD cases available at http://www.cdc.gov/vhf/ebola/outbreaks/2014-west-africa/united-states-imported-case.html.

# Ebola Outbreak, West Africa

- **On August 8, the World Health Organization (WHO) declared that the current Ebola outbreak is a Public Health Emergency of International Concern (PHEIC)**




- This declaration underscores the need for a coordinated international response to contain the spread of Ebola

# CHALLENGES IN WEST AFRICA

# Outbreak Challenges, West Africa

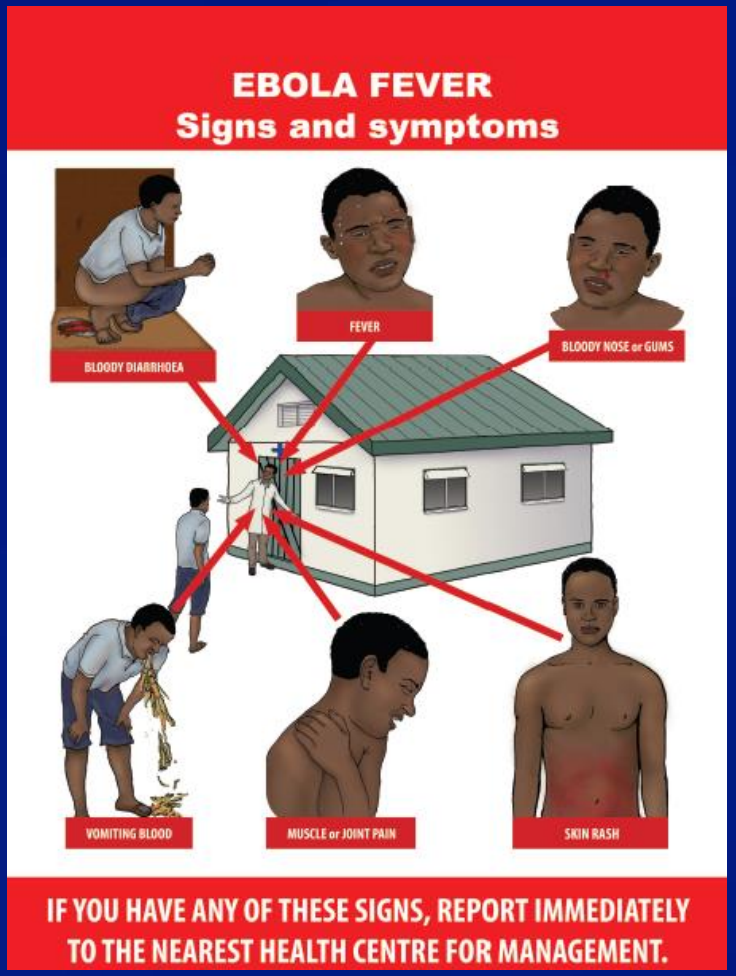
- Porous borders
- High population mobility
- Geographic breadth

# Outbreak Challenges in West Africa


- Lack of sanitation / Infection Prevention
- Overburdened public health / healthcare systems
  - Unpaid healthcare workers
  - Insufficient treatment centers, beds, medical supplies, and personal protective equipment (PPE)

# Outbreak Challenges: Lack of acceptance of Ebola

- **Not overcome by education**
- **Fear and superstition**
  - Health posters
- **Stigma**
  - Needing to share negative test results to return to work
- **Distrust of outsiders**
  - Brought Ebola to make money
- **Role of war exposure**



# WHAT CDC IS DOING IN WEST AFRICA

# CDC Deployments

- **Hundreds of CDC staff have deployed in response to Ebola**

- **Currently deployed (12/8/14): 263**
  - West Africa: 176
  - Other countries: 1
  - CDC EOC
  - United States, assess state and local readiness

# Overall Goals in Outbreak Response

- **Patient Care**
  - Experienced and/or trained staff
  - Strict use of personal protective equipment (PPE)
- **Stop human to human transmission**
  - Case identification
  - Contact tracing
  - Infection control

# Overall Goals in Outbreak Response

- **Community education**
  - Text messages, radio and video messages in local languages, fact sheets, health posters and pamphlets


Facts About Ebola Infographic (English)
[PDF - 1 page]

Facts About Ebola Infographic (French)
[PDF - 1 page]

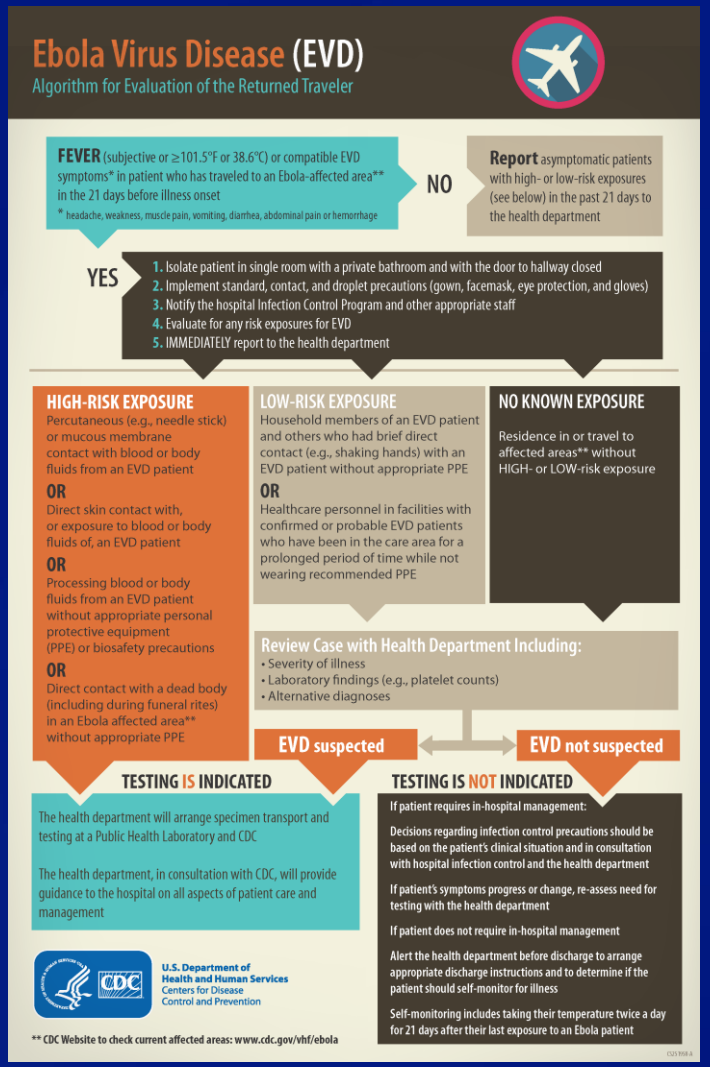
Facts About Ebola Infographic (Spanish)
[PDF - 1 página]

Listen to Ebola radio health messages in local languages.

# WHAT CDC IS DOING IN THE U.S.

# Numerous Guidance Documents

- Healthcare Provider
- Laboratory
- Evaluating Patients & Returning Travelers
- Monitoring & Movement of Persons with EVD Exposure



# CDC DEPLOYMENTS

# Lagos, Nigeria: August – September 2014



- **Estimated population: >21M**

# Lagos, Nigeria: August – September 2014

- **Provide Infection Prevention expertise, consultation to Nigeria Federal and Lagos State Ministries of Health**
  - Facility set-up & assessment
  - Infection prevention education
  - Identification of resources
- **Collaborate with national and international partners**

# Lagos, Nigeria: August – September 2014

# Lagos, Nigeria: August – September 2014

- **Key Challenges:**
  - Gaps in federal and state infrastructure
    - Funding, personnel, priorities
  - Large number of healthcare facilities in Lagos State (>3,000 public and private facilities)
    - Lack of comprehensive list of healthcare facilities
  - Lack of adequate hand washing facilities and available PPE at healthcare facilities
  - Lack of infection prevention and control knowledge and appropriate use of PPE among healthcare providers
  - Method to rapidly disseminate information / educate broadly

# Lagos, Nigeria: August – September 2014

# Lagos, Nigeria: August – September 2014

# Lagos, Nigeria: August – September 2014

- **Key Accomplishments:**
  - Established multi-disciplinary Work Group
    - Guide trainings, training strategy
  - Developed educational curriculum & all supporting documents:
    - Basics of Ebola, Basics of Infection Prevention and Control, Screening and Isolation in Healthcare Facilities, Appropriate Use of PPE
  - Launched training sessions:
    - 16 sessions held, >960 persons trained
  - Held TOT (train the trainer) session: 89 attendees

# Lagos, Nigeria: August – September 2014

- **Key Accomplishments:**
  - Guided development of Hand Hygiene campaign information
    - Community outreach, contact tracers
  - Worked with partners to improve safety of Ebola Treatment Unit
  - Procured donations of funding specifically for training
  - Developed strategic plans
    - Dissemination of training within Lagos and throughout Nigeria
    - Ebola preparedness and response in Nigeria (at request of Incident Manager)

# Lagos, Nigeria: August – September 2014

Before and After: Ebola Isolation Ward Makes Improvements

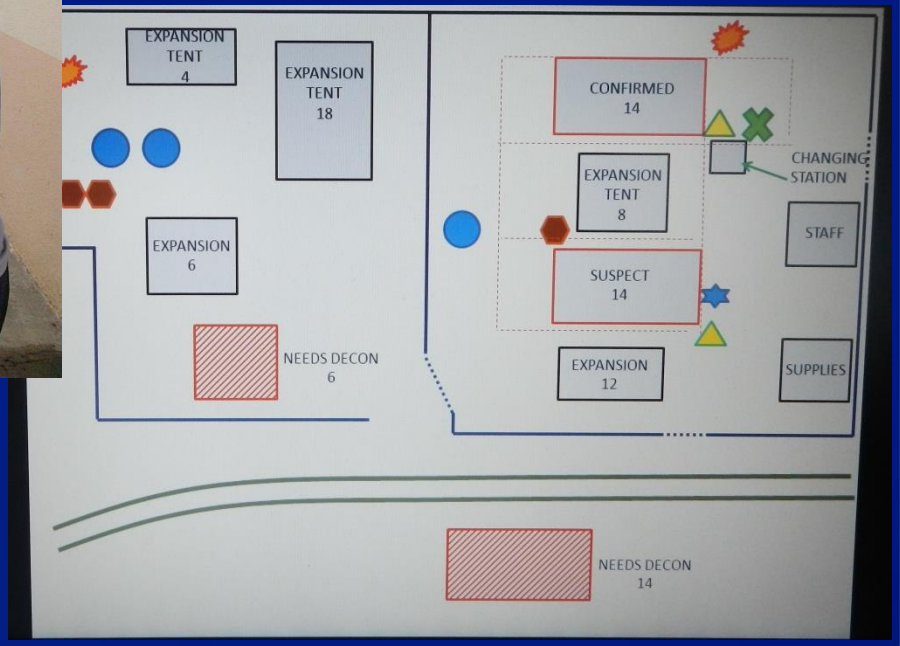

*Published August 29, 2014*

Watch this Before and After Tour of Ebola Isolation Ward safety improvements to compound in Lagos, Nigeria.

http://www.cdc.gov/vhf/ebola/resources/videos.html

# Lagos, Nigeria: August – September 2014

# Lagos, Nigeria: August – September 2014



# Atlanta, CDC EOC: September – October 2014

- **Co-Team Lead for International Infection Prevention and Control Team**
  - Oversight & guidance of response efforts specific to infection prevention in Guinea, Liberia, Nigeria, and Sierra Leone
  - Infection prevention training for healthcare workers in-country
  - Identify sources of funding, NGOs, external partners to deploy and provide infection prevention assessment, consultation, mentoring in Ebola-affected countries

# Atlanta, CDC EOC: September – October 2014

- **Accomplishments: Infection Prevention Trainings**

***As of 10/9/14:**

| Country | No. of Trainings Held | No. of Persons Trained | No. of TOTs Held | No. of Master Trainers (MT) Trained |
|---|---|---|---|---|
| Liberia | 13 | 2609 | 2 | 200 |
| Sierra Leone | 5 | 179 | 1 | 20 |
| Guinea | 3 | 1100 | 0 | 0 |
| Nigeria | 40 | 2300 | 4 | 204 (91 selected) |

# Lagos, Nigeria: August – September 2014

# NORTH CAROLINA DIVISION OF PUBLIC HEALTH

- **Donning and Doffing of Personal Protective Equipment (PPE) in Hospital Ebola Isolation Units**

- **Partners**
  - N.C. SPICE
  - UNC Healthcare System
  - Duke University Health System

# Thank you


Jennifer MacFarquhar, RN, MPH, CIC, teaching healthcare volunteers in Nigeria - August 2014